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(54) A projection type liquid crystal display

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Dispositif d'affichage à crystal liquide du type à projection

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(73) Proprietor: **SHARP KABUSHIKI KAISHA**
Osaka-shi, Osaka-fu 545 (JP)

(72) Inventors:
- **Ishii, Yutaka**
  Nara-shi, Nara-ken (JP)
- **Yamamoto, Yoshitaka**
  Yamatokoriyama-shi, Nara-ken (JP)

(74) Representative: **White, Martin David et al**
MARKS & CLERK,
57/60 Lincoln's Inn Fields
London WC2A 3LS (GB)

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- **PATENT ABSTRACTS OF JAPAN vol. 15, no. 382 (P-1257)26 September 1991 & JP-A-03 152 526**
- **PATENT ABSTRACTS OF JAPAN vol. 12, no. 125 (P-691)19 April 1988 & JP-A-62 250 425**

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates to a projection type liquid crystal display which is provided in audio visual (AV) equipment, office automation (OA) equipment, computers, etc.

2. Description of the Related Art:

In recent years, with the development of the advanced information society, there has been a great demand for a display having a large size as well as a large display capacity. In order to meet the demand, high precision has been advanced in a cathode ray tube (CRT) called "A kind of a Display". In addition, in order to achieve the enlargement of the display, a direct vision type CRT with a size of 40 inches and a projection type CRT with a size of 20 inches have been developed. However, there arise problems to be solved, involving weight and depth of the CRT along with the realization of the display with a large size and a large capacity.

A flat display is used for a word processor, a personal computer, etc. The flat display forms a display using a principle different from that of the CRT. Regarding the flat display, a display with high quality has been studied, which is required in a display with high vision and used for high performance engineering work stations (EWS).

Examples of the flat display include an electroluminescence panel (ELP), a plasma display panel (PDP), a vacuum fluorescent display (VFD), an electrochromic display (ECD), and a liquid crystal display (LCD). Among these flat displays, the LCD is considered to be most useful because of easiness of a full-color display and matching with a large scale integrated circuit (LSI). Thus, the LCD has been remarkably developed.

There are two kinds of LCDs: a simple matrix drive LCD and an active matrix drive LCD. The simple matrix drive LCD has a structure in which liquid crystal is sealed in an XY matrix panel, and forms a display taking advantage of the rapid response property of the liquid crystal. The XY matrix panel is obtained by disposing a pair of glass substrates so as to face each other, each glass substrate having electrodes formed in a stripe shape so that the electrodes formed on one substrate cross those formed on the other substrate. The active matrix drive LCD has a structure in which non-linear elements are directly added to pixels, and performs a display positively taking advantage of the non-linear properties (e.g., switching property) of each element. Thus, the active matrix drive LCD is less dependent upon the display property of liquid crystal itself, compared to that of the simple matrix drive LCD, and thus it enables it to create displays with high contrast and high-speed response. The non-linear element has two types: a two-terminal type and a three-terminal type. Examples of the two-terminal non-linear element include a metal-insulator-metal (MIM) and a diode. Examples of the three-terminal non-linear element include a thin film transistor (TFT), a silicon metal oxide semiconductor (Si-MOS), and a silicon-on-sapphire (SOS).

In recent years, the projection type LCD has been actively developed so on to meet the demand for more powerful images. In particular, in order to obtain an image with high quality, the projection type display such an an active matrix drive LCD has been studied and marketed positively.

Figure 9 shows a typical prior art example of the reflective LCD. In this reflective LCD, white light emitted from a lamp 100 is divided into red, green, and blue components by dichroic mirrors 101, 102, and 103. Lights with the respective color components are transmitted through liquid crystal panels 104, 105, and 106 for each color and synthesized so as to be an image by dichroic mirrors 107 and 108. The synthesized image is magnified by a lens 109 so as to be projected with color on a front face or a back face of a large screen (not shown).

However, the LCD shown in Figure 9 is a problem because of its large size. In order to avoid the enlargement of the LCD, it is required that the liquid crystal panels 104, 105, and 106 are made small, and optical components such as the lamp 100, the mirror 101, 102, 103, 107, and 108 and the lens 109 are made small so as to correspond to the miniaturized liquid crystal panels 104, 105, and 106, whereby the whole optical system is miniaturized. Along with the miniaturization of the optical components, it is also required to provide the optical components with high magnification. Moreover, in order to avoid a decrease in image quality caused by magnifying an image with high magnification, it is required to provide the liquid crystal panels with a high resolution.

Figure 10 shows the relationship between the number of pixels and the numerical aperture of a current TFT-LCD. As the number of pixels increases, an LCD will have a higher resolution. As shown in Figure 10, the numerical aperture is decreased as the resolution is increased, resulting in a dark display. In addition, in the case where the liquid crystal panels are miniaturized under the condition that the display capacity (an area which substantially contributes to a display) is constant, similar problems will arise. Moreover, as shown in Figure 9, the conventional projection type LCD has a structure in which an optical system for color division and an optical system for color synthesis are separately disposed, so that the length of an optical path for performing the color division and color synthesis prevents the miniaturization of the LCD.

There is a strong demand for a three-dimensional projection type display. A system shown in Figure 11 has conventionally been proposed in order to realize a three-dimensional display (S. Yano and I. Yuyama; Japan Display '89 p. 48). In the system of Figure 11, a high-vision

signal emitted from a signal source 118 for a right eye is given to a CRT 119 for a right eye equipped with a polarizing filter, and an image formed in the CRT 119 is projected on a screen 120. A high-vision signal emitted from a signal source 121 for a left eye is given to a CRT 122 for a left eye equipped with a polarizing filter, and an image formed in the CRT 122 is projected on the screen 120. In this case, light components of the images for a right eye and a left eye are polarized, and the polarization directions of the respective images are shifted by 90°. A viewer watches an image displayed on the screen 120, wearing polarizing eye-glasses 123, the respective lenses of the glasses having the polarization directions shifted by 90°, whereby the viewer can watch the image three-dimensionally. However, in this system, there is a problem in that the formation of an image in adversely influenced by geomagnetism because of the use of the CRT with high precision. Moreover, the system includes two CRTs 119 and 122 and the screen 120, so that the system is hardly miniaturized.

The three-dimensional display is also made possible in the following manner:

1) Two projection type LCDs (as shown in Figure 9) for a right eye and a left eye are used; and

2) Three liquid crystal panels for displaying an image for a right eye and three liquid crystal panels for displaying an image for a left eye are disposed in one box.

However, it is difficult to miniaturize the display.

US-A-4 647 966, on which the preamble of claim 1 is based, discloses a projection type liquid crystal display comprising: an optical source; a light dividing means for dividing light from the optical source into a first light and a second light which have different polarization directions, and for directing the first light and the second light in different directions from each other; a first reflective liquid crystal display element and a second reflective liquid crystal element for respectively displaying a first image and a second image, each of the first and second reflective liquid crystal display elements including a pair of substrates facing each other, and a liquid crystal layer disposed between the substrates, the first light and the second light being incident on the first reflective liquid crystal display element and the second reflective liquid crystal display element respectively and then outgoing therefrom carrying the first image and the second image, respectively; a driving means for driving the first reflective liquid crystal display element and the second reflective liquid crystal display element so that the first image and the second image are displayed in synchronisation with each other; a light synthesizing means for synthesizing the first light and the second light into image light; and a screen on which the image light is projected. Liquid crystal light valves are used as the reflective liquid crystal displays. Data are optically written into the light valves, so the device requires means for supplying optical images to the light valves. It is difficult to synchronise the images displayed on the two light valves, and it is also difficult to reduce the size of the display.

US-A-5 028 121 discloses a projection device in which white light is split into three components of different wavelengths in order to produce a colour display.

According to the present invention there is provided a projection type liquid crystal display of the above type characterised in that each of the liquid crystal display elements comprises a plurality of of display electrodes forming a matrix on the surface of the active matrix substrate (18) for selectively changing optical characteristics of the liquid crystal layer by selectively applying an electric field to the liquid crystal layer in accordance with an image to be displayed, whereby the first and second images are electrically provided.

Preferred features of the invention are set out in dependent claims 2 to 16.

According to the present invention, light emitted from the optical source is incident upon the light dividing unit and the incident light is divided into an S-polarized light and a P-polarized light. The light dividing unit reflects the S-polarized light on a slope thereof, and allows the P-polarized light to be transmitted therethrough, whereby the incident light is divided. The light dividing unit functions as the light synthesizing unit, so that the respective images displayed on the first and second reflective liquid crystal display elements are combined by the light dividing unit (light synthesizing unit). Thus, one of the divided lights by the light dividing unit is reflected from the first reflective liquid crystal display element and is incident upon the light dividing unit again. The polarization direction of light is changed by the liquid crystal, so that the light reflected from the first reflective liquid crystal display element contains a P-polarized light (i.e., light which is optically modulated by the liquid crystal) and an S-polarized light (i.e., light which is not optically modulated by the liquid). The S-polarized light among the lights reflected from the first reflective liquid crystal display element proceeds to the optical source, and the P-polarized light passes through the slope of the light dividing unit to the screen.

The other light of the divided light is reflected from the second reflective liquid crystal display element and returns to the light dividing unit. The light which returns to the light dividing unit contains a P-polarized light (i. e., light which is not optically modulated by the liquid crystal) and an S-polarized light (i.e., light which is optically modulated by the liquid crystal). The P-polarized light among the lights reflected from the second reflective liquid crystal display element proceeds to the optical source and the S-polarized light is reflected from the slope of the light dividing unit to proceed to the screen. At this time, the driving circuit synchronizes the first and second reflective liquid crystal display elements, thereby allowing images to be displayed. Thus, a combined

image can be formed on the screen.

According to the projection type liquid crystal display, an image to be formed on one of the reflective liquid crystal display elements is taken as an image for a right eye and an image to be formed on the other reflective liquid crystal display element is taken as an image for a left eye. A three-dimensional image formed of the images for right and left eyes is caught by the eyeglasses, whereby a viewer can watch an object and the like three-dimensionally. Moreover, in the case where identical images are formed on the two reflective liquid crystal display elements, a remarkably bright non-three-dimensional image can be formed.

Thus, the invention described herein makes possible the advantages of (1) providing a projection type liquid crystal display capable of performing a non-three-dimensional display as well as a three-dimensional display; (2) providing a projection type liquid crystal display in which the formation of an image is not adversely influenced by geomagnetism; and (3) providing a miniaturized projection type liquid crystal display with high resolution.

These and other advantages of the present invention will become apparent to those skilled in the art upon reading and understanding the following detailed description with reference to the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic view showing a projection type liquid crystal display according to the present invention.

Figure 2a is a cross-sectional view of a liquid crystal display element together with an electrical circuit.

Figure 2b is a cross-sectional view of a light selection unit together with an electrical circuit.

Figure 3 is a timing chart regarding an applied voltage together with the kind of transmitted light.

Figure 4 is a perspective view showing a mechanical R.G.B. rotary filter.

Figure 5 is a block diagram showing a driving circuit.

Figure 6 is a timing chart regarding a scanning time, etc. together with the kind of transmitted light.

Figure 7 is a cross-sectional view showing a liquid crystal display element in which a color filter is integrated.

Figure 8 is a perspective view showing a liquid crystal display element in which a frame memory is provided.

Figure 9 is a schematic view showing a conventional projection type liquid crystal display.

Figure 10 is a graph showing the relationship between the number of pixels and the numerical aperture.

Figure 11 is a schematic diagram showing a conventional three-dimensional display system.

Figure 12 is a view showing another example of a light selection unit applicable to the present invention.

Figure 13 is a view showing still another example of a light selection unit applicable to the present invention.

Figure 14 is a view showing still another example of a light selection unit applicable to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, the present invention will be described by way of illustrating an example with reference to the drawings.

Example

Figure 1 shows a projection type liquid crystal display of the present example capable of performing a color display. The display of the present example includes an optical source 1, a light selection unit 13, a beam splitter 70, first and second reflective liquid crystal display elements 12 and 12', an optical system, and a screen 6. The optical source 1 emits, for example, white light. The white light is incident upon the light selection unit 13, where the light is formed into three primary colors. The beam splitter 70 divides the light transmitted through the light selection unit 13 into two polarized lights a and b. The two polarized lights a and b come out of the beam splitter 70, having different polarization directions. The first and second reflective liquid crystal display elements 12 and 12' are provided in each optical path of the polarized lights a and b, and are regulated by a display control circuit 16 and driving circuits 14 (shown in Figure 2). The optical system is constituted by the beam splitter 70 and a lens 5 disposed on the right side of the beam splitter 70. Light with respect to respective images formed on the first and second reflective liquid crystal display elements **12** and **12'** comes out through the beam splitter **70** in a direction of **c**, and light **c** is magnified by the lens **5** so as to be projected on the screen **6**.

The operation of the display shown in Figure **1** is as follows:

The white light emitted from the optical source **1** passes through the light selection unit **13** and is incident upon the beam splitter **70**. Part of the light incident upon the beam splitter **70** is reflected from a slope **70a** of the beam splitter **70** so as to become light **a** (S-polarized light). The remaining part of the light passes through the slope 70a to become light **b** (P-polarized light).

The lights **a** and **b** are incident upon the reflective liquid crystal display elements **12** and **12'**, respectively. Among the lights reflected from the reflective liquid crystal display elements **12** and **12'**, optically modulated lights, i.e., lights having image information travel in the opposite directions of the incidence directions of the lights **a** and **b**. These lights are again incident upon the beam splitter **70** so as to be combined. The light **c** (i.e., the optically modulated and combined light) is magnified by the lens **5** in order to be projected on the screen **6**.

In the projection type liquid crystal display which functions as described above, in the case where an image for a right eye and an image for a left eye are formed on the reflective liquid crystal display elements 12 and 12', a three-dimensional display can be performed; and in the case where the identical images are formed on the reflective liquid crystal display elements 12 and 12', non-three-dimensional display can be performed. Regarding the three-dimensional display, it is required that an image formed on the screen 6 is caught by polarizing eyeglasses (not shown). Regarding the non-three-dimensional display, it is not required to use polarizing eyeglasses. Moreover, the projection type liquid crystal display of the present invention can be used as a front type display or a rent type display. In the case of the front type display, an image is projected on the front side of the screen 6 (i.e., on the side where the viewer is positioned). In the case of the rear type display, an image is projected on the back side of the screen 6 (i.e., on the side opposite the viewer's position with respect to the screen 6). Furthermore, in the case of the rear type display, if the screen 6 is provided with a lenticular lens in a rectangular shape, a three-dimensional display can be shown without polarizing eyeglasses.

Hereinafter, each component will be described in detail.

(Light selection unit 13)

The light selection unit 13 is shown in Figure 2b. The light selection unit 13 provides the images formed on the reflective liquid crystal display elements 12 and 12' with color. The light selection unit 13 is disposed on the side of a transparent substrate 17 of the reflective liquid crystal display element 12, and is formed of a cyan filter 29C, a magenta filter 29M, and a yellow filter 29Y, which are layered in that order. The cyan filter 29C includes a pair of transparent substrates 20 and 21 facing each other, and a transparent electrode (not shown) is formed on each inside surface of the transparent substrates 20 and 21. Liquid crystal 22 containing a cyan dichroic dye (described later) is inserted between the transparent substrates 20 and 21. The magenta filter 29M includes a pair of transparent substrates 23 and 24 facing each other, and a transparent electrode (not shown) is formed on each inside surface of the transparent substrates 23 and 24. Liquid crystal 25 containing a magenta dichroic dye (described later) is inserted between the transparent substrates 23 and 24. The yellow filter 29Y includes a pair of transparent substrates 26 and 27 facing each other, and a transparent electrode (not shown) is formed on each inside surface of the transparent substrates 26 and 27. Liquid crystal 28 containing a yellow dichroic dye (described later) is inserted between the transparent substrates 26 and 27.

The cyan filter 29C, the magenta filter 29M, and the yellow filter 29Y are applied with an AC voltage from AC power sources 31 via switching circuits 30C, 30M, and 30Y, respectively. The switching circuits 30C, 30M, and 30Y selectively apply an AC voltage to the cyan filter 29C, the magenta filter 29M, and the yellow filter 29Y based on a switching signal from the display control circuit 16, thereby driving each filter. As described above, the on/off of each filter is regulated, whereby light with either one of three primary colors, i.e., red, green, or blue can be incident upon the reflective liquid crystal display elements 12 and 12'. The following Table 1 shows the relationship between the state of each driven filter and the color of the incident light.

Table 1

Drive state			Color of incident light
29C	29M	29Y	
ON	OFF	OFF	Red
OFF	ON	OFF	Green
OFF	OFF	ON	Blue

Figure 3 is a timing chart showing the fundamental operation of the light selection unit 13. The cyan filter 29C is applied with a voltage from t_1 to t_3. The orientation of liquid crystal molecules are not immediately changed by being applied with a voltage and a predetermined transition period τ is required. The transition period τ corresponds to a response recovery speed of the liquid crystal molecules with respect to an electrical field. Thus, even though the application of the voltage starts at t_1, it is not until t_2 that liquid crystal molecules in the cyan filter 29C actually respond to the voltage, and the orientation thereof becomes stable. Accordingly, the light transmitted through the light selection unit 13 becomes red during TR (from t_2 to t_3).

In the same way as the above, a voltage is repeatedly applied to the magenta filter 29M, the yellow filter 29Y, and the cyan filter 29C, respectively in this order, whereby each light transmitted through the light selection unit 13 becomes green, blue, and red. The structure of the light selection unit 13 is not limited to the present example. The light selection unit 13 can be formed using three kinds of liquid crystals containing red, blue, and green dichroic dyes. Moreover, as long as any color can be converted to a desired one at high speed, any structure is applicable: e.g., a laminate of color polarizing plates and liquid crystal panels; a laminate of neutral gray polarizing plates and liquid crystal panels; and a mechanical rotary filter as shown in Figure 4. According to the mechanical rotary filter shown in Figure 4, light emitted from an optical source 96 is transmitted through a UV-cut filter 97, whereby the UV-rays are removed. The light from which the UV-rays are removed is transmitted through a mechanical R.G.B. rotary filter 98 so as to be colored light, and the resulting light is transmitted through a lens 99.

The position of the light selection unit 13 is not limited to a place between the optical source 1 and the

beam splitter 70. The light selection unit 13 can be disposed at any position between the optical source 1 and the lens 5. In the case where the light selection unit 13 is disposed between the liquid crystal display elements 12 and 12' and the beam splitter 70, two light selection units are required for the respective liquid crystal display elements 12 and 12'.

Another example of the light selection unit 13 is shown in Figure 12. An optical fiber 80 which divides light into three components is provided on the light emitting side of an optical source 1. Light converged by the fiber 80 is divided into three components. An optical system, e.g., another optical fiber 82 is provided so as to sandwich a light shutter between the optical fibers 80 and 82. The light shutter is formed of color filters 81a, 81b, and 81c; and light switching elements 81d, 81e, and 81f for each component. The optical system 82 synthesizes lights transmitted through the light shutter. Examples of the color filters 81a, 81b, and 81c include color filters using a dye or a pigment; and interference filters in which inorganic or organic optical thin films are layered. Examples of a material for the light switching elements 81d, 81e, and 81f include ceramics such as liquid crystal and PLZT. As the liquid crystal used for the light switching elements 81d, 81e, and 81f, liquid crystal with the following general display modes are applicable: a dispersion type display mode, an optical rotation type display mode, a double refraction type display mode, and a light absorption type display mode. Particularly, in the case where a high-speed response is required, the use of polymer dispersion type liquid crystal, phase transition liquid crystal, ferroelectric liquid crystal, antiferroelectirc liquid crystal, or the like is desired.

Another methods can be used for dividing light. For example, as shown in Figure 13, light is taken out of an optical source 1 as three components by using three lenses 83a, 83b, and 83c; and fibers 83d, 83e, and 83f. Alternatively, lights are separately introduced into filters from three optical sources (not shown). Alternatively, as shown in the lower part of Figure 14, an optical source 1 and a beam splitter 84 (or a plurality of dichroic mirrors) are combined. For synthesizing light, as shown in the upper part of Figure 14, a beam splitter 85 (or a plurality of dichroic mirrors) is used.

(Beam splitter 70)

The beam splitter 70 is formed of two prisms 72 and 73. The two prisms 72 and 73 are combined so that the respective slopes face each other. The beam splitter 70 divides non-polarized light which is incident upon the slope 70a thereof into the S-polarized light a and the P-polarized light b. The S-polarized light a comes out of the bean splitter 70 into the reflective liquid crystal display element 12, and the P-polarized light b comes out of the beam splitter 70 into the reflective liquid crystal display element 12'. The beam splitter 70 allows the S-polarized light a which is reflected from the liquid crystal display element 12 to be transmitted therethrough, and reflects the P-polarized light b which is reflected from the reflective liquid crystal display element 12' on the slope 70a, whereby the polarized lights a and b come out of the beam splitter 70 under the condition of being combined.

The optical member which functions as described above is not limited to the beam splitter 70. Any optical member, which divides non-polarized light into S-polarized light and P-polarized light, and which allows both polarized lights reflected from the liquid crystal display elements 12 and 12' (i.e., polarized lights having image information) to come out of the optical member under the condition that both polarized lights are combined, can be used. For example, the combination of a plurality dichroic mirrors can be used. It is noted that the use of the beam splitter 70 reduces the number of members and thus contributes to the miniaturization of the device.

(Reflective liquid crystal display elements 12 and 12')

The reflective liquid crystal display elements 12 and 12' have the same structure. The structure of the reflective liquid crystal display element 12 will be described.

The reflective liquid crystal display element 12 is an active matrix type and uses liquid crystal in a mode employing a polarizing plate, e.g., TN liquid crystal having, for example, 45° twisted orientation. The structure of the reflective liquid crystal display element 12 is shown in Figure 2a. The reflective liquid crystal display element 12 includes a transparent substrate 17, an active matrix substrate 18, and liquid crystal 19. The transparent substrate 17 and the active matrix substrate 18 are disposed so as to face each other. On the active matrix substrate 18, there is a light reflection panel for reflecting light which is incident thereupon through the transparent substrate 17. One common electrode is formed over almost the entire surface of the transparent substrate 17, which faces the active matrix substrate 18, and a plurality of display electrodes are formed in a matrix on the surface of the active matrix substrate 18, which faces the transparent substrate 17. Regions where the common electrode and the display electrodes overlap each other become display regions (pixels).

In the reflective liquid crystal display elements 12 and 12', a driving voltage is applied between the common electrode and the display electrodes by the driving circuits 14 which are connected to the reflective liquid crystal display elements 12 and 12', respectively, whereby a predetermined display is performed. The display control signal transmitted from the display control circuit 16 which is common to the reflective liquid crystal display elements 12 and 12' regulates the driving circuits 14.

Each driving circuit 14 writes a driving signal for a subsequent image, while a desired display is performed by the reflective liquid crystal display element 12 or 12'. Figure 5 shows a structure of the driving circuit 14. The

driving circuit 14 has a signal scanning portion 32 regulated with a display control signal; capacitors 33a and 33b for storing a driving signal from the signal scanning portion 32; a switch SW_1, by which the driving signal from the signal scanning portion 32 is switched to be supplied to the capacitor 33a or 33b; and a switch SW_2, by which the driving signal stored at the capacitor 33a or 33b is switched to be supplied to a pixel driving portion 34. The driving circuit 14 is partially or entirely built in the active matrix substrate 18.

In the case of a three-dimensional display, the display control circuit 16 transmits per frame an image signal for a left eye to one driving circuit 14, and an image signal for a right eye to the other driving circuit 14. These image signals for right and left eyes respectively include image signals having red, green, and blue components per frame. Moreover, the display control circuit 16 transmits switching signals to the signal scanning portion 32 so as to be given to the SW_1 and SW_2 per frame and each image signal with red, green, and blue components. The switching signals are also given to the switching circuits 30C, 30M, and 30Y of the light selection unit 13.

The driving circuit 14 functions as follows:

While each liquid crystal (pixel) 35 is driven by the driving signal stored in the capacitor 33b, a driving signal for a subsequent image, which is transmitted through the signal scanning portion 32 and the switch SW_1, is stored in the capacitor 33a. Such an operation is conducted with respect to each pixel. A driving signal for a subsequent image to be displayed by each pixel is taken in the capacitor 33a of the driving circuits 14. After the driving signal is taken in the reflective liquid crystal display elements 12 and 12', or the driving circuits 14, the switch SW_1 provided so as to correspond to each pixel is switched from a terminal b_1 to a terminal a_1 at appropriate timing; and the switch SW_2 is switched from a terminal a_2 to a terminal b_2. Because of the switching of the switches SW_1 and SW_2, display images of the reflective liquid crystal display elements 12 and 12' are immediately changed into subsequent images. More specifically, each liquid crystal 35 is driven by the driving signal stored in the capacitor 33a. During this time, a driving signal for a further subsequent image is stored in the capacitor 33b, whereby the driving signal is taken in the reflective liquid crystal display elements 12 and 12' or the driving circuits 14. Then, the above-mentioned operation is repeated.

When the above-mentioned operation is conducted, the switch timing of a display image, i.e., switch timing of the switches SW_1 and SW_2 is synchronized with the color-change timing of the light election unit 13, whereby a color display of images for right and left eyes is made possible. A period W_2 shown in Figure 6 corresponds to a response characteristic of a display mode applied to the reflective liquid crystal display element 12, and it is preferred that the period W_2 is as short as possible.

In the light selection unit 13, it is possible to avoid mixing two colors (i.e., blue and red, red and green, green and blue) by taking appropriate timing to apply each voltage to the cyan filter 29C, the magenta filter 29M, and the yellow filter 29Y. Owing to the appropriate timing to apply to each voltage, timing to start a period W_2 shown in Figure 6 can properly be designed.

Moreover, in the reflective liquid crystal display elements 12 and 12', there is a problem of light reflection on some portions other than the light reflection panel (e.g., the surface of the transparent substrate 17, the surface of the transparent electrode, and interfaces between various thin films (not shown) formed between the transparent substrate 17 and the active matrix substrate 18); however, the formation of anti-reflection films on these portions overcomes this problem and is useful for enhancing contrast characteristics.

Furthermore, there is a problem of response characteristics for each liquid crystal element. Since the lowest limit of frequency at which human eyes do not see a flickering of a display is about 30 Hz, in the present example, the allowable time for a display corresponding to each color (red, blue, and green) is about 10 msec. In order to perform an adequate display within 10 msec, it is required that the response time of the reflective liquid crystal display element 12 be several msec or less. In order to display each color for a plurality of times during one frame period, a liquid crystal element which has a short response time is required. Moreover, in the case where the light selection unit 13 formed of filters of each color including a liquid crystal element is used, as in the present example, the same response characteristics as those of the reflective liquid crystal display element 12 are required in the liquid crystal element of the light selection unit 13.

The inventors of the present invention studied various liquid crystal display elements in view of the above-mentioned response characteristics. As a result, it was found that a phase transition mode to which a dichroic dye is added, a polymer dispersion type liquid crystal display mode, a high-speed response type TN mode (e.g., two-frequency type liquid crystal), homogeneous nematic liquid crystal mode, a ferroelectric liquid crystal display mode, and an antiferroelectric liquid crystal display mode are preferred as a liquid crystal display mode.

An example of a method for manufacturing a liquid crystal display element using a polymer dispersion type liquid crystal display mode will be described.

A diacrylate oligomer and a photopolymerization initiator are dissolved in nematic liquid crystal E7 of cyanobiphenyl type to obtain a homogeneous solution with liquid crystal concentration of 95% by weight. Separately, a polyimide film is formed on a glass substrate with a transparent electrode and is subjected to rubbing so that a pretilt angle of nematic liquid crystal is almost 2°. The solution obtained is inserted between the glass substrate thus obtained and a polycarbonate substrate so that the liquid crystal molecules are oriented in a hori-

zontal direction with respect to the substrate and the thickness thereof is regulated with a spacer. The cell thus obtained is irradiated with UV-rays while being applied with an AC voltage of 30 V, whereby the oligomer is polymerized. After that, the polycarbonate substrate is removed from the cell, and the liquid crystal is thoroughly dissolved in an organic solvent and then dried. Next, another glass substrate with a transparent electrode formed in the same way is attached to the above-mentioned glass substrate so as to form a panel. Liquid crystal ZLI-4788/000 (manufactured by Merck & Co., Inc.) is sealed in the panel.

In the liquid crystal display element thus obtained, the liquid crystal molecules are oriented in a vertical direction with respect to the substrate under no electrical field. Therefore, when light is incident upon the liquid crystal display element, the polarization direction of the incident light is the same as that of light which comes out of the liquid crystal element. However, when sufficient voltage is applied to the liquid crystal display element, the liquid crystal molecules are oriented in the horizontal direction with respect to the substrate. Thus, when light is incident upon the liquid crystal display element so that the orientation of the liquid crystal molecules and the polarization direction of the incident light forms an angle, the polarization direction of light which comes out of the liquid crystal display element is different from that of the incident light. The same effects can be obtained in the case where elliptically polarized light or circularly polarized light is incident upon the liquid crystal display element.

According to a conventional orientation technique using the combination of oblique evaporation and an orientation agent for realizing a homeotropic structure, there have been problems such as non-uniformity of the orientation of the liquid crystal molecules and durability of the liquid crystal display element due to evaporation. In contrast, according to the above-mentioned method, evaporation is not required, thus eliminating such problems. Moreover, according to the above-mentioned method, high-speed response characteristics of polymer dispersion type liquid crystal can be provided to the liquid crystal display element, so that less problems arise relating to response, compared with the conventional electrically controlled birefringence (ECB) mode. Furthermore, in the case where liquid crystal whose molecules are oriented in the horizontal direction under no electrical field is used, light is leaked due to rotary dispersion, resulting in a degraded contrast. In the liquid crystal display element manufactured as described above, the liquid crystal molecules are oriented in an almost vertical direction under no electrical field, so that light is hardly leaked due to rotary dispersion. Thus, a display with high contrast can be realized.

The above-mentioned liquid crystal material has negative dielectric anisotropy and its molecules are uniformly oriented in the horizontal direction with respect to the substrate when applied with an AC voltage. The beam splitter 70 is disposed so that the slope 70a and the orientation directions of liquid crystal molecules of the reflective liquid crystal display elements 12 and 12' form an angle of 45° (i.e., the polarized lights which come out of the beam splitter 70 shown in Figure 1 cross each other), whereby a high contrast display without hysterisis can be obtained.

As described above, in the present example, light emitted from the optical source 1 is colored after passing through the light selection unit 13. After that, the light passes through the beam splitter 70 and the liquid crystal display elements 12 and 12' and returns to the beam splitter 70. At this time, image components for a right eye and a left eye are combined so as to be incident upon the lens 5. The combined image is magnified by the lens 5 and projected on the screen 6.

A viewer watches the image displayed on the screen 6, wearing the polarizing eyeglasses (not shown). The polarizing eyeglasses have a polarizing plate for a right eye and a polarizing plate for a left eye, each plate having a different polarization direction. For example, the polarizing plate for a right eye catches polarized light which comes out of the liquid crystal display element 12' (which displays an image for a right eye), and the polarizing plate for a left eye catches polarized light which comes out of the liquid crystal display element 12 (which displays an image for a left eye). Thus, by wearing the polarizing eyeglasses, the viewer can watch an object three-dimensionally.

The light emitted from the optical source 1 can be polarized by more than 0° and less than 180° instead of 90° as long as the image for a right eye and that for a left eye can readily be recognized. It is preferred that the angle is in the range of 45° to 135°.

In addition, it is also possible that a birefringent plate is disposed between the beam splitter 70 and the screen 6; and linearly polarized lights which come out of the reflective liquid crystal display elements 12 and 12' are converted into circularly polarized lights, the plane of each polarized light being rotated differently, followed by being projected on the screen 6. In this case, eyeglasses to be used have phase plates and polarizing plates. More specifically, when circularly polarized light is incident upon the eyeglasses, the circularly polarized light for a right eye and that for a left eye are respectively converted into linearly polarized lights by the phase plates of the eyeglasses, each polarization direction being different. The linearly polarized lights pass through the polarizing plates of the eyeglasses, whereby the image for a right eye is caught by a right eye and that for a left eye is caught by a left eye.

In the projection type liquid crystal display of the present example, a non-three-dimensional display can be performed in addition to the above-mentioned three-dimensional display. In the case where the non-three-dimensional display is performed, the identical images are displayed on the reflective liquid crystal display elements 12 and 12'. More specifically, the identical im-

ages are displayed on the reflective liquid crystal display elements 12 and 12' by two kinds of lights, each having different polarization direction. When the non-three-dimensional display is performed in the conventional projection type liquid crystal display as shown in Figure 9, there arises a problem. That is, in the conventional projection type liquid crystal display, a transmission type liquid crystal panel is used in a display mode employing a polarizer, such as a TN mode, so that more than half of the amount of light is lost and the numerical aperture, with respect to the number of pixels, is decreased due to the presence of the polarizer, thus degrading the brightness of a display. In contrast, according to the projection type liquid crystal display of the present example, all of the lights emitted from the optical source can be used for displaying an image without being lost in an optical path. Moreover, the numerical aperture with respect to the number of the pixels can be improved due to the use of the reflective liquid crystal display elements 12 and 12', compared with the use of transmission type liquid crystal display elements. As a result, a remarkably bright display can be obtained.

Furthermore, in the conventional projection type liquid crystal display, it is required to use three liquid crystal elements. In contrast, in the projection type liquid crystal display according to the present invention, two liquid crystal display elements are used. For this reason, the present invention has advantages of size, weight, and cost.

As described above, both the three-dimensional display and non-three-dimensional display can be obtained with the projection type liquid crystal display of the present invention. In the case where the non-three-dimensional display is obtained with this projection type liquid crystal display, almost all of the lights which are incident upon the beam splitter 70 can come out thereof as lights having image information, and thus, a bright image can be displayed on the screen 6. In addition, because of the use of the reflective liquid crystal display elements 12 and 12', the formation of an image is not adversely influenced by geomagnetism. Moreover, a color display is readily obtained by disposing the light selection unit 13 on the light incidence side of the reflective liquid crystal display elements 12 and 12' or on the light outgoing side thereof. An image is projected on a screen, so that there is no limit to the visual field and a number of people can watch the image together. Furthermore, the use of the above-mentioned liquid crystal can prevent flickering, leading to improved resolution. The improved resolution can realize the miniaturization of the three-dimensional display system.

As TN liquid crystal having a 45° twisted orientation which is used for the liquid crystal display elements 12 and 12', the usual nematic liquid crystal is applicable. In order to obtain the high speed of the response, it is required to consider the viscosity of the material. In general, liquid crystal with a size of 35 centipoises (cp) or less exhibits effects for realizing the present invention. From experience, the inventors of the present invention found that liquid crystal with a size of 25 cp or less is preferred. Examples of the material exhibiting such characteristics include biphenyl compounds, phenylester compounds, cyclohexane compounds, phenylpyrimidine compounds, dioxane compounds, diphenylacetylene compounds, alkenyl compounds, fluorine compounds, and mixtures thereof. The twisted angle of liquid crystal is not limited to 45°. Moreover, as a display mode, any modes which use polarized light can be used. Examples of the display mode include a TN mode, a phase transition mode, a guest-host mode, a polymer dispersion type liquid crystal display mode, a homogeneous type liquid crystal display mode, a ferroelectric liquid crystal display mode, an antiferroelectric liquid crystal display mode, and an electroclinic liquid crystal display mode.

In the present example, the light selection unit 13 is used for performing a color display. In place of that, a color display is also made possible in a structure in which a color microfilter is provided on each pixel by dyeing, electrodeposition, printing, etc. In this case, instead of successively displaying red, green, and blue components by the liquid crystal display elements 12 and 12' while an image for a right eye or an image for a left eye is projected on the screen 6, a color signal corresponding to each pixel is simultaneously transmitted while the image for a right eye or the image for a left eye in projected on the screen 6. Thus, In the system using a color microfilter, the response speed required for the reflective liquid crystal display alements 12 and 12' can be three times slower than that in the case where the light selection unit 13 is used as in the present example. Accordingly, as to the display mode and the liquid crystal material, wide selection is made possible because of the reduced limitation of the response speed.

As the substrate 18, a substrate made of glass or crystal such as silicon is used. On such a substrate, nonlinear elements such as a thin film transistor (TFT) or a diode are formed, and the elements are formed of amorphous silicon and/or polysilicon. In particular, a crystal substrate is desired, since the driving circuit (a memory circuit for storing a signal) 14 can readily be provided behind each pixel. Figure 7 shows a reflective liquid crystal display element having a color microfilter and a silicon substrate. In Figure 7, switching circuit and memory circuit regions 93 of liquid crystal 92 are formed on a monocrystalline silicon substrate 91. Here, three switching circuit regions 93 are formed as one group. Each electrode 94 which also functions as a reflective film is formed on each switching circuit and memory circuit region 93, and under this condition, a gelatin film is formed over the entire surface of the monocrystalline silicon substrate 91. Each upper portion of the gelatin film, which corresponds to the respective three switching circuit and memory circuit regions 93 as one group of pixels is dyed in red, green, and blue. The respective colored portions are made of a red color filter 94a, a green

color filter 94b, and a blue color filter 94c, and the remaining portions are left as the gelatin film (undyed region 94d). In Figure 7, the reference numeral 95 denotes a transparent glass substrate provided so as to face the silicon substrate 91, and the reference numeral 95a denotes a transparent counter electrode formed over the entire inner surface of the substrate 95.

Moreover, the liquid crystal display elements 12 and 12' can have a structure in which a frame memory is built as shown in Figure 8. More specifically, a liquid crystal display portion 72 is formed at the center region on a monocrystalline silicon substrate 71 (base), and at the periphery of the liquid crystal display portion 72, a liquid crystal driving circuit 73, a circuit portion 74 including a memory circuit, an image processing circuit, and the like are formed. An input signal is processed in the circuit portion 74, and is transferred to the liquid crystal driving circuit 73, whereby an image is displayed on the liquid crystal display portion 72.

In the case where a liquid crystal display element of this type is used, since the monocrystalline silicon substrate is used, an IC technique is applicable. That is, a microprocessing technique, a method for forming a high quality thin film, a method for implanting impurities with high precision, etc. can be used. In addition, because of the application of these methods, the advantages of achieving high precision, high speed operation, and high reliability are realized.

As described above, according to the present invention, almost all of the lights which are incident upon the optical members such as the beam splitter, mirror, or the like (which divides non-polarized light into two kinds of polarized lights, each having a different polarization direction) can be taken out as light having image information for right and left eyes or as light having single image information. Thus, a bright image without flickering can be displayed three-dimensionally or non-three-dimensionally. In addition, a color display can be performed by providing the light selection unit, the color filter, or the mechanical R.G.B. rotary filter on the side of the liquid crystal display element. Moreover, resolution can be improved by using a memory circuit and applying an IC microprocessing technique.

Various other modifications will be apparent to and can be readily made by those skilled in the art. Accordingly, it is not intended that the scope of the invention to be limited to the description as set forth herein, but by the appended claims.

Claims

1. A projection type liquid crystal display comprising: an optical source (1);

a light dividing means (70) for dividing light from the optical source into a first light and a second light which have different polarization directions, and for directing the first light and the second light in different directions from each other;

a first reflective liquid crystal display element (12) and a second reflective liquid crystal element (12') for respectively displaying a first image and a second image, each of the first and second reflective liquid crystal display elements including a pair of substrates (17,18) facing each other, and a liquid crystal layer (19) disposed between the substrates, the first light and the second light being incident on the first reflective liquid crystal display element and the second reflective liquid crystal display element respectively and then outgoing therefrom carrying the first image and the second image, respectively;

a driving means for driving the first reflective liquid crystal display element and the second reflective liquid crystal display element so that the first image and the second image are displayed in synchronisation with each other;

a light synthesizing means (70) for synthesizing the first light and the second light into image light; and

a screen (6) on which the image light is projected;

characterised in that each of the liquid crystal display elements (12,12') comprises a plurality of display electrodes forming a matrix on the surface of the active matrix substrate (18) for selectively changing optical characteristics of the liquid crystal layer by selectively applying an electric field to the liquid crystal layer in accordance with an image to be displayed, whereby the first and second images are electrically provided.

2. A projection type liquid crystal display according to claim 1, wherein the light synthesizing means also functions as the light dividing means.

3. A projection type liquid crystal display according to claim 1 or 2, wherein the light dividing means is a beam splitter.

4. A projection type liquid crystal display according to any one of claims 1-3, further comprising a light selection means (13) for converting the light from the optical source into any one of a red light, a green light, and a blue light.

5. A projection type liquid crystal display according to claim 4, wherein the light selection means is formed of a cyan filter, a magnets filter, and a yellow filter.

6. A projection type liquid crystal display according to claim 4 or 5, wherein the light selection means is driven to selectively covert the light from the optical

source into one of the red light, the green light, and the blue light in a time divisional manner.

7. A projection type liquid crystal display according to claim 5, wherein the cyan filter, the magnets filter, and the yellow filter have a pair of transparent substrates facing each other and a further liquid crystal layer between the pair of transparent substrates, respectively.

8. A projection type liquid crystal display according to claim 4, wherein the light selection means is a mechanical R.G.B. rotary filter.

9. A projection type liquid crystal display according to any one of the preceding claims, wherein each of the first reflective liquid crystal display element and the second reflective liquid crystal display element has a plurality of pixels and color filters formed on each pixel, and wherein the plurality of electrodes includes a common electrode formed on one of the substrates and a plurality of display electrodes formed on the other of the substrates, portions where the common electrode and the display electrodes are overlapped being pixels.

10. A projection type liquid crystal display according to any one of the preceding claims, wherein at least one of the pair of substrates is a transparent substrate, and the first light or the second light are incident upon the transparent substrate.

11. A projection type liquid crystal display according to claim 10, wherein each of the first and second reflective liquid crystal display elements further includes a reflection means and a non-reflection means, the reflection means is formed to face the transparent substrate and reflects the first light or the second light, and the non-reflection means is formed on the side of the transparent substrate upon which the first light or the second light is incident.

12. A projection type liquid crystal display according to any one of the preceding claims, wherein one substrate of the pair of substrates is a silicon substrate, and the driving means is formed on the silicon substrate.

13. A projection type liquid crystal display according to claim 11, wherein the first reflective liquid crystal display element and the second reflective liquid crystal display element have a plurality of pixels, respectively, and the driving means is formed on a back face of the plurality of pixels.

14. A projection type liquid crystal display according to claim 12 or 13, wherein the first reflective liquid crystal display element and the second reflective liquid crystal display element have a display portion formed of the plurality of pixels and the driving means is formed in the periphery of the display portion.

15. A projection type liquid crystal display according to any one of the preceding claims, wherein an angle formed by the polarization directions of the first light and the second light from the light dividing means is in the range of 45° to 135°.

16. A projection type liquid crystal display according to any one of the preceding claims, wherein the first light and the second light from the light dividing means are an S-polarized light and a P-polarized light, and the liquid crystal layer converts the S-polarized light into light having a P-polarized component and the P-polarized light into light having a S-polarized component.

Patentansprüche

1. Projektionstyp-Flüssigkristallanzeige mit einer optischen Quelle (1),

einer Lichtteilungseinrichtung (70) zum Teilen des Lichtes von der optischen Quelle in ein erstes Licht und ein zweites Licht, die verschiedene Polarisationsrichtungen haben, und zum Richten des ersten Lichtes und des zweiten Lichtes in voneinander verschiedene Richtungen,

einem ersten reflektierenden Flüssigkristallanzeigeelement (12) und einem zweiten reflektierenden Flüssigkristallanzeigeelement (12'), um jeweils ein erstes Bild und ein zweites Bild anzuzeigen, wobei jedes der ersten und zweiten reflektierenden Flüssigkristallanzeigeelemente ein Paar von einander gegenüberliegenden Substraten (17, 18) und eine zwischen den Substraten gelegene Flüssigkristallschicht (19) hat, das erste Licht und das zweite Licht auf das erste reflektierende Flüssigkristallanzeigeelement bzw. das zweite reflektierende Flüssigkristallanzeigeelement einfällt und dann von dort unter Mitnahme des ersten Bildes bzw. des zweiten Bildes nach außen geht,

einer Ansteuereinrichtung zum Ansteuern des ersten reflektierenden Flüssigkristallanzeigeelementes und des zweiten reflektierenden Flüssigkristallanzeigeelementes, so daß das erste Bild und das zweite Bild synchron miteinander angezeigt sind,

einer Lichtzusammensetzeinrichtung (70) zum

Zusammensetzen des ersten Lichtes und des zweiten Lichtes in ein Bildlicht, und

einem Schirm (6), auf den das Bildlicht projiziert ist,

dadurch gekennzeichnet, daß jedes der Flüssigkristallanzeigeelemente (12, 12') eine Vielzahl von eine Matrix auf der Oberfläche des aktiven Matrixsubstrates (18) bildenden Anzeigeelektroden zum wahlweisen Ändern optischer Charakteristiken der Flüssigkristallschicht durch wahlweises Anlegen eines elektrischen Feldes an die Flüssigkristallschicht gemäß einem anzuzeigenden Bild aufweist, wodurch die ersten und zweiten Bilder elektrisch geliefert sind.

2. Projektionstyp-Flüssigkristallanzeige nach Anspruch 1, bei der die Lichtzusammensetzeinrichtung auch als die Lichtteilungseinrichtung arbeitet.

3. Projektionstyp-Flüssigkristallanzeige nach Anspruch 1 oder 2, bei der die Lichtteilungseinrichtung ein Strahlteiler ist.

4. Projektionstyp-Flüssigkristallanzeige nach einem der Ansprüche 1 bis 3, weiterhin mit einer Lichtwähleinrichtung (13) zum Umsetzen des Lichtes von der optischen Quelle in ein Licht aus einem roten Licht, einem grünen Licht und einem blauen Licht.

5. Projektionstyp-Flüssigkristallanzeige nach Anspruch 4, bei der die Lichtwähleinrichtung durch ein Cyan-Filter, ein Magenta-Filter und ein Gelb-Filter gebildet ist.

6. Projektionstyp-Flüssigkristallanzeige nach Anspruch 4 oder 5, bei der die Lichtwähleinrichtung angesteuert ist, um wahlweise das Licht von der optischen Quelle in ein Licht aus dem roten Licht, dem grünen Licht und dem blauen Licht in einer Zeitteilungsweise umzusetzen.

7. Projektionstyp-Flüssigkristallanzeige nach Anspruch 5, bei der das Cyan-Filter, das Magenta-Filter und das Gelb-Filter ein Paar von transparenten, einander gegenüberliegenden Substraten und weiterhin eine Flüssigkristallschicht zwischen dem Paar der transparenten Substrate jeweils aufweisen.

8. Projektionstyp-Flüssigkristallanzeige nach Anspruch 4, bei der die Lichtwähleinrichtung ein mechanisches RGB-Drehfilter ist.

9. Projektionstyp-Flüssigkristallanzeige nach einem der vorangehenden Ansprüche, bei der jedes der ersten reflektierenden Flüssigkristallanzeigeelemente und der zweiten reflektierenden Flüssigkristallanzeigeelemente eine Vielzahl von Pixels und auf jedem Pixel gebildete Farbfilter hat, wobei die Vielzahl von Elektroden eine gemeinsame Elektrode, die auf einem der Substrate ausgebildet ist, und eine Vielzahl von Anzeigeelektroden, die auf dem anderen der Substrate ausgebildet sind, umfaßt, wobei Teile, an denen die gemeinsame Elektrode und die Anzeigeelektroden überlappt sind, Pixels bilden.

10. Projektionstyp-Flüssigkristallanzeige nach einem der vorangehenden Ansprüche, bei der wenigstens ein Substrat des Paares von Substraten ein transparentes Substrat ist und bei der das erste Licht oder das zweite Licht auf das transparente Substrat einfällt.

11. Projektionstyp-Flüssigkristallanzeige nach Anspruch 10, bei der jedes der ersten und zweiten reflektierenden Flüssigkristallanzeigeelemente weiterhin eine Reflexionseinrichtung und eine Nicht-Reflexionseinrichtung umfaßt, die Reflexionseinrichtung gebildet ist, um dem transparenten Substrat gegenüber zu liegen und das erste Licht oder das zweite Licht reflektiert und die Nicht-Reflexionseinrichtung auf der Seite des transparenten Substrates gebildet ist, auf die das erste Licht oder das zweite Licht einfällt.

12. Projektionstyp-Flüssigkristallanzeige nach einem der vorangehenden Ansprüche, bei der ein Substrat des Paares von Substraten ein Siliziumsubstrat ist und bei der die Ansteuereinrichtung auf dem Siliziumsubstrat ausgebildet ist.

13. Projektionstyp-Flüssigkristallanzeige nach Anspruch 11, bei der das erste reflektierende Flüssigkristallanzeigelement und das zweite reflektierende Flüssigkristallanzeigeelement jeweils eine Vielzahl von Pixels haben und bei der die Ansteuereinrichtung auf einer Rückfläche der Vielzahl von Pixels ausgebildet ist.

14. Projektionstyp-Flüssigkristallanzeige nach Anspruch 12 oder 13, bei der das erste reflektierende Flüssigkristallanzeigeelement und das zweite reflektierende Flüssigkristallanzeigeelement einen Anzeigeteil haben, der aus der Vielzahl von Pixels gebildet ist, und bei der die Ansteuereinrichtung im Rand des Anzeigeteiles gebildet ist.

15. Projektionstyp-Flüssigkristallanzeige nach einem der vorangehenden Ansprüche, bei der ein Winkel, der durch die Polarisationsrichtungen des ersten Lichtes und des zweiten Lichtes von der Lichtteilungseinrichtung gebildet ist, in dem Bereich von 45° bis 135° liegt.

16. Projektionstyp-Flüssigkristallanzeige nach einem der vorangehenden Ansprüche, bei der das erste Licht und das zweite Licht von der Lichtteilungseinrichtung ein S-polarisiertes Licht und ein P-polarisiertes Licht sind, und bei der die Flüssigkristallschicht das S-polarisierte Licht in Licht mit einer P-polarisierten Komponente und das P-polarisierte Licht in Licht mit einer S-polarisierten Komponente umsetzt.

Revendications

1. Dispositif d'affichage à cristal liquide du type à projection comprenant une source optique (1),

   un moyen diviseur de lumière (70) pour diviser la lumière provenant de la source optique en une première lumière et en une seconde lumière qui ont différentes directions de polarisation, et pour diriger la première lumière et la seconde lumière dans des directions différentes l'une de l'autre,
   un premier élément d'affichage à cristal liquide réfléchissant (12) et un second élément à cristal liquide réfléchissant (12') pour afficher, respectivement, une première et une seconde images, chacun des premier et second éléments d'affichage à cristal liquide réfléchissants comprenant deux substrats (17, 18) en regard l'un de l'autre, et une couche de cristal liquide (19) disposée entre les substrats, la première lumière et la seconde lumière tombant sur le premier élément d'affichage à cristal liquide réfléchissant et sur le second élément d'affichage à cristal liquide réfléchissant, respectivement, et en sortant, en portant la première et la seconde images, respectivement,
   un moyen de commande pour commander le premier élément d'affichage à cristal liquide réfléchissant et le second élément d'affichage à cristal liquide réfléchissant de telle sorte que la première image et la seconde image soient affichées en synchronisation l'une avec l'autre,
   un moyen de synthèse de la lumière (70) pour synthétiser la première lumière et la seconde lumière pour former une lumière porteuse d'image, et
   un écran sur lequel la lumière porteuse d'image est projetée,

   caractérisé en ce que chacun des éléments d'affichage à cristal liquide (12, 12') comprend une série d'électrodes d'affichage formant une matrice sur la surface du substrat à matrice active (18) pour modifier sélectivement les caractéristiques optiques de la couche de cristal liquide en appliquant sélectivement un champ électrique à la couche de cristal liquide conformément à une image à afficher, la première et la seconde images étant obtenues par voie électrique.

2. Dispositif d'affichage à cristal liquide du type à projection selon la revendication 1, dans lequel le moyen de synthèse de la lumière joue également le rôle de moyen diviseur de lumière.

3. Dispositif d'affichage à cristal liquide du type à projection selon la revendication 1 ou 2, dans lequel le moyen diviseur de lumière est un diviseur de faisceau.

4. Dispositif d'affichage à cristal liquide du type à projection selon l'une quelconque des revendications 1 à 3, comprenant par ailleurs un moyen de sélection de lumière (13) pour convertir la lumière provenant de la source optique en l'une quelconque de lumières rouge, verte et bleue.

5. Dispositif d'affichage à cristal liquide du type à projection selon la revendication 4, dans lequel le moyen de sélection de lumière est formé d'un filtre cyan, d'un filtre magenta et d'un filtre jaune.

6. Dispositif d'affichage à cristal liquide du type à projection selon la revendication 4 ou 5, dans lequel le moyen de sélection de lumière est commandé pour convertir sélectivement la lumière provenant de la source optique en l'une de lumières rouge, verte et bleue dans un mode programmé dans le temps.

7. Dispositif d'affichage à cristal liquide du type à projection selon la revendication 5, dans lequel le filtre cyan, le filtre magenta et le filtre jaune ont deux substrats transparents en regard l'un de l'autre et une autre couche de cristal liquide entre les deux substrats transparents, respectivement.

8. Dispositif d'affichage à cristal liquide du type à projection selon la revendication 4, dans lequel le moyen de sélection de lumière est un filtre rotatif RVB mécanique.

9. Dispositif d'affichage à cristal liquide du type à projection selon l'une quelconque des revendications précédentes, dans lequel chacun des premier élément d'affichage à cristal liquide réfléchissant et second élément d'affichage à cristal liquide réfléchissant a une série de pixels et de filtres couleurs formés sur chaque pixel, et dans lequel la série d'électrodes comprend une électrode commune formée sur l'un des substrats et une série d'électrodes d'affichage formées sur l'autre des substrats, les parties où l'électrode commune et les électrodes d'affichage se chevauchent étant des pixels.

10. Dispositif d'affichage à cristal liquide du type à projection selon l'une quelconque des revendications précédentes, dans lequel au moins un des deux substrats est un substrat transparent et la première ou la seconde lumière tombe sur le substrat transparent.

11. Dispositif d'affichage à cristal liquide du type à projection selon la revendication 10, dans lequel chacun des premier et second éléments d'affichage à cristal liquide réfléchissants comprend par ailleurs un moyen réfléchissant et un moyen non réfléchissant, le moyen réfléchissant est formé de manière à être en regard du substrat transparent et réfléchit la première lumière ou la seconde lumière, et le moyen non réfléchissant est formé sur le côté du substrat transparent sur lequel la première ou la seconde lumière tombe.

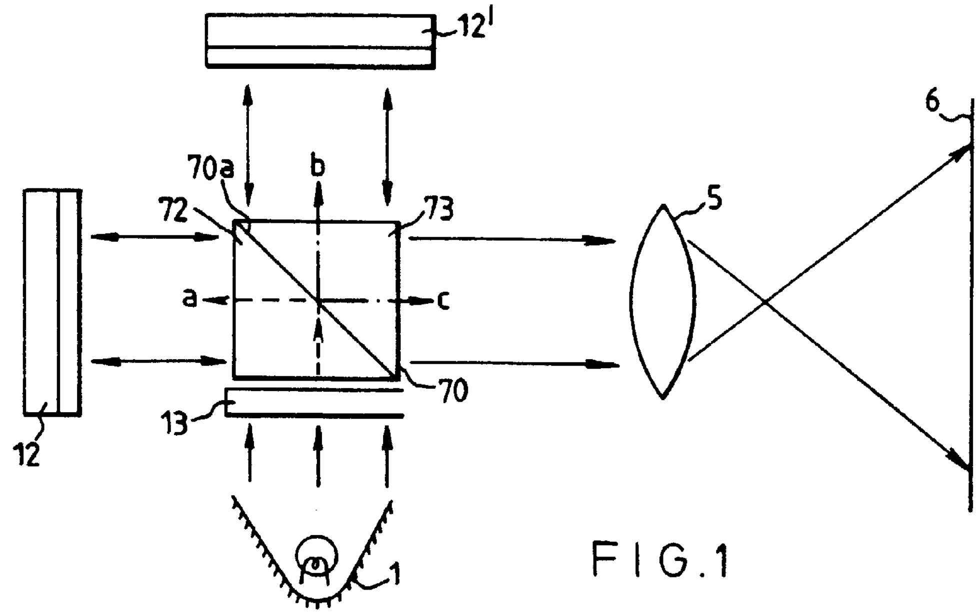
12. Dispositif d'affichage à cristal liquide du type à projection selon l'une quelconque des revendications précédentes, dans lequel un des deux substrats est un substrat de silicium et le moyen de commande est formé sur le substrat de silicium.

13. Dispositif d'affichage à cristal liquide du type à projection selon la revendication 11, dans lequel le premier élément d'affichage à cristal liquide réfléchissant et le second élément d'affichage à cristal liquide réfléchissant ont une série de pixels, respectivement, et le moyen de commande est formé au verso de la série de pixels.

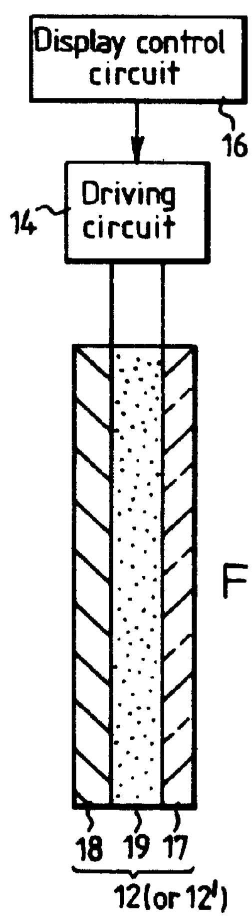
14. Dispositif d'affichage à cristal liquide du type à projection selon la revendication 12 ou 13, dans lequel le premier élément d'affichage à cristal liquide réfléchissant et le second élément d'affichage à cristal liquide réfléchissant ont une partie d'affichage formée de la série de pixels et le moyen de commande est formé sur la périphérie de la partie d'affichage.

15. Dispositif d'affichage à cristal liquide du type à projection selon l'une quelconque des revendications précédentes, dans lequel l'angle formé par les directions de polarisation de la première lumière et de la seconde lumière provenant du moyen diviseur de lumière se situe dans une plage de 45 à 135°.

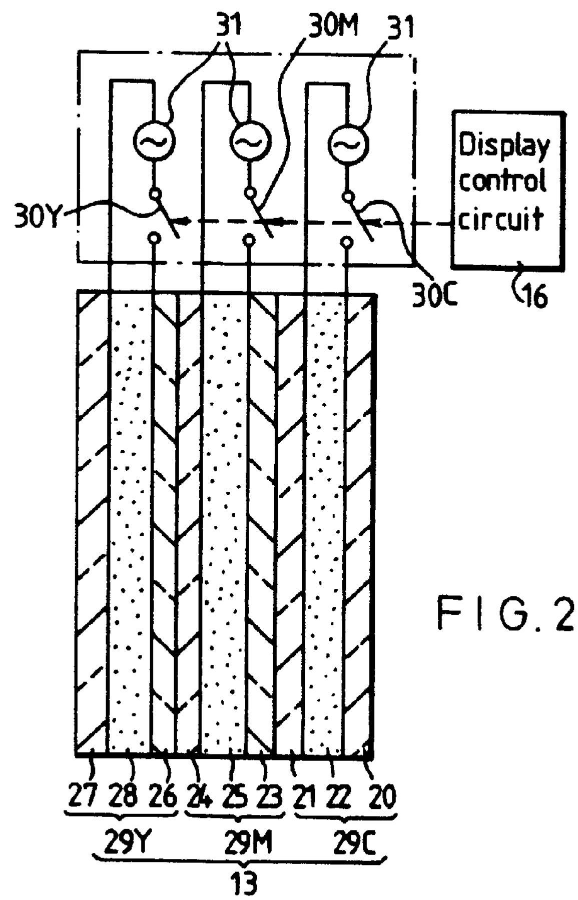
16. Dispositif d'affichage à cristal liquide du type à projection selon l'une quelconque des revendications précédentes, dans lequel la première lumière et la seconde lumière provenant du moyen diviseur de lumière sont une lumière polarisée S et une lumière polarisée P, et la couche de cristal liquide convertit la lumière polarisée S en lumière ayant une composante polarisée P et la lumière polarisée P en lumière ayant une composante polarisée S.



F I G.1



F I G. 2a



F I G. 2b

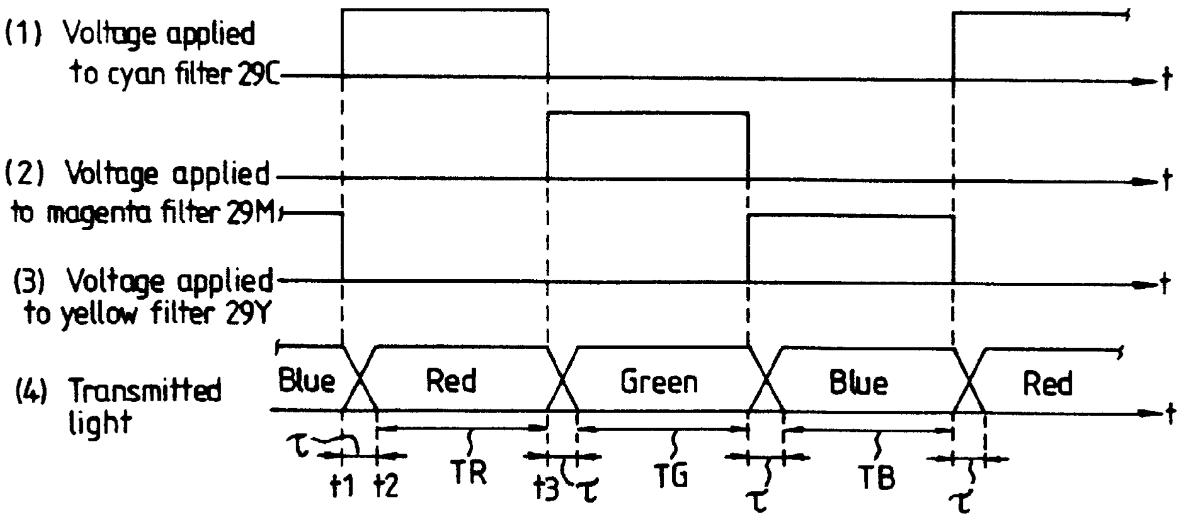


FIG.3

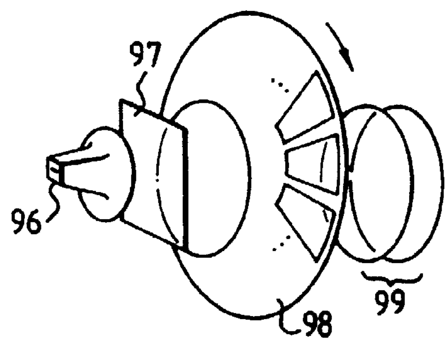


FIG.4

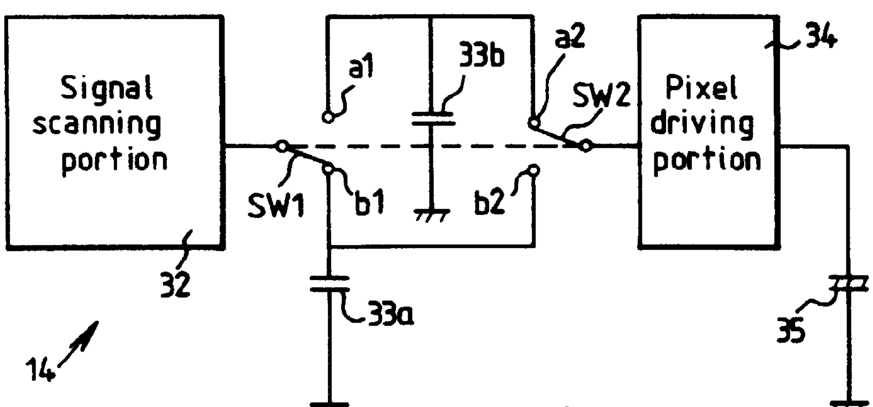
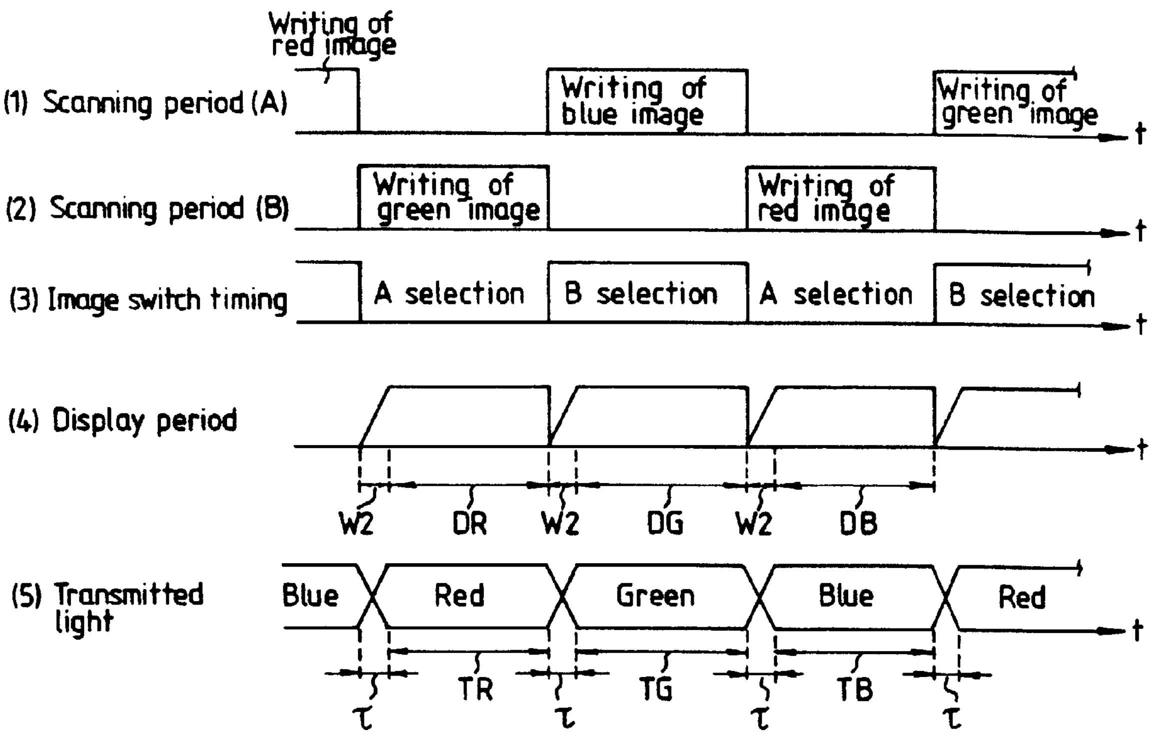
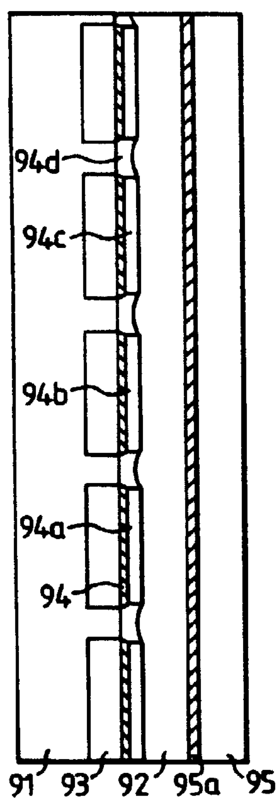


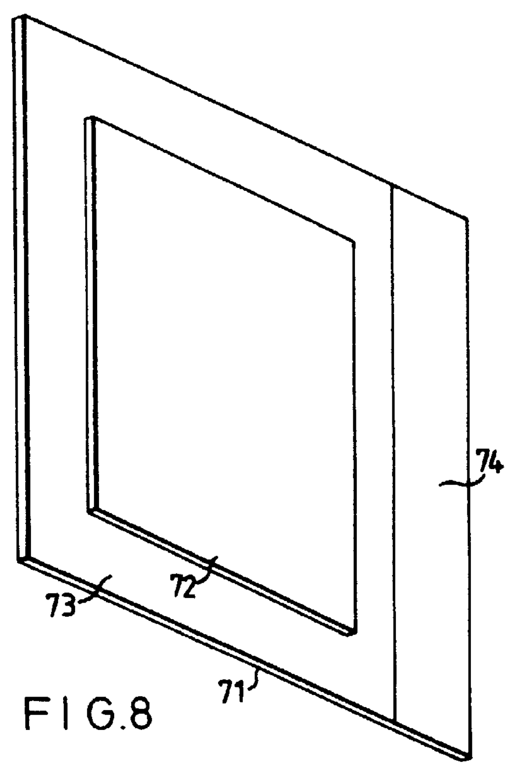
FIG.5



F I G.6



F I G.7



F I G.8

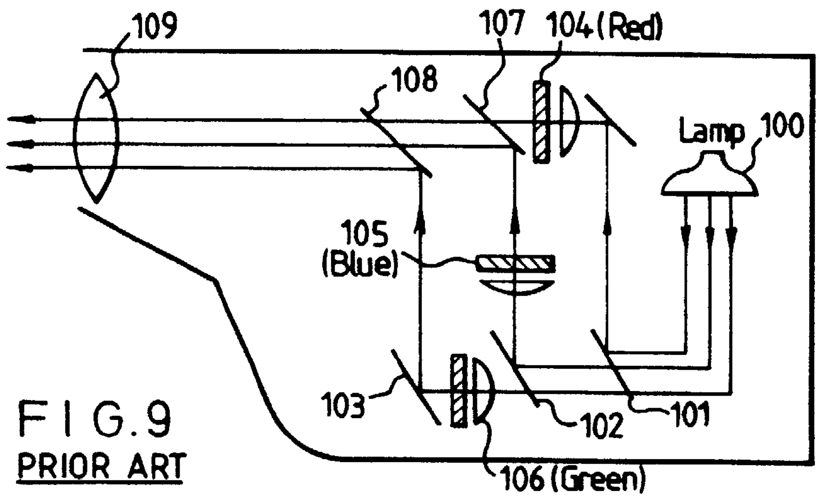


FIG.9
PRIOR ART

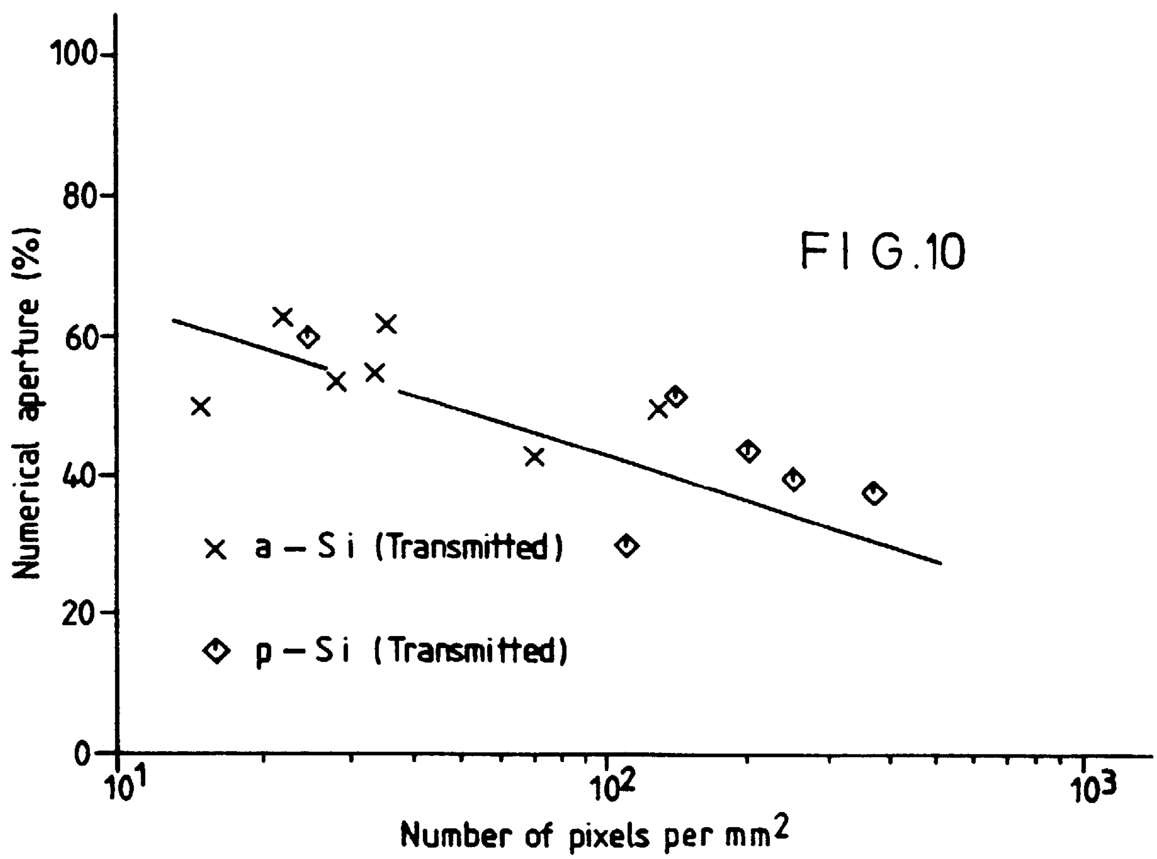
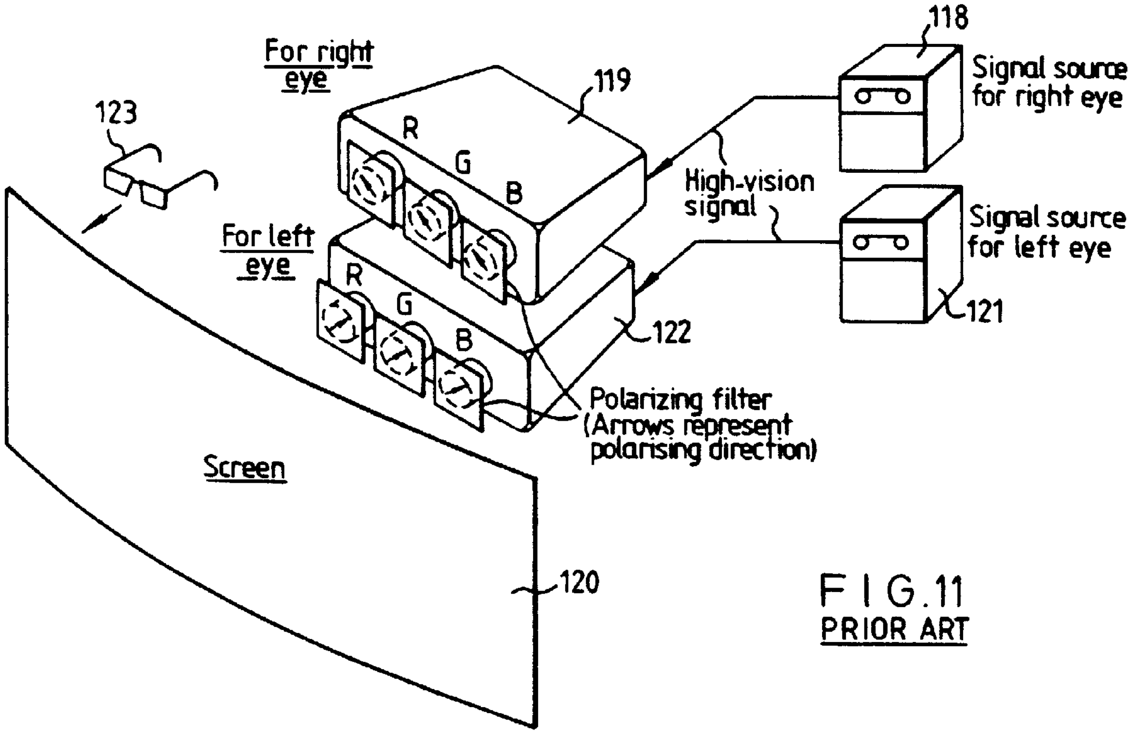
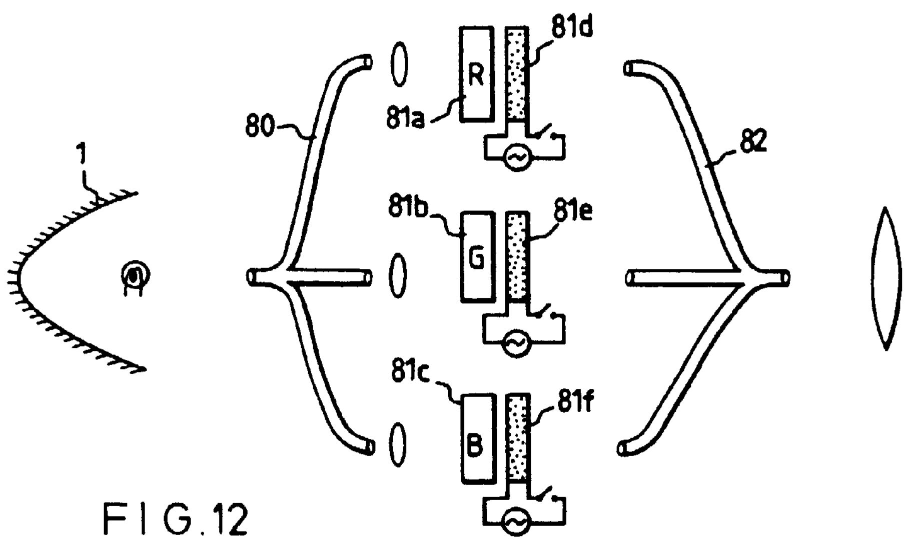


FIG.10



F I G.11
PRIOR ART



F I G.12

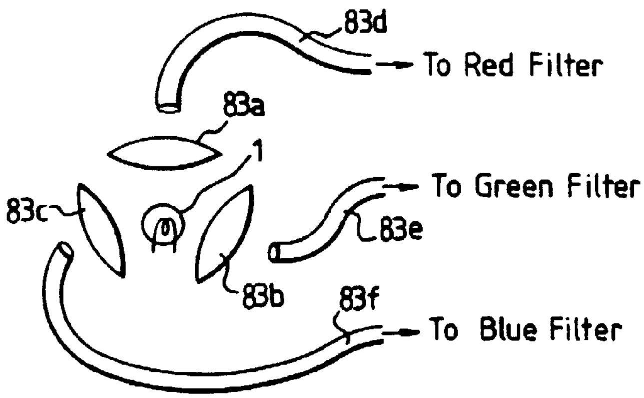
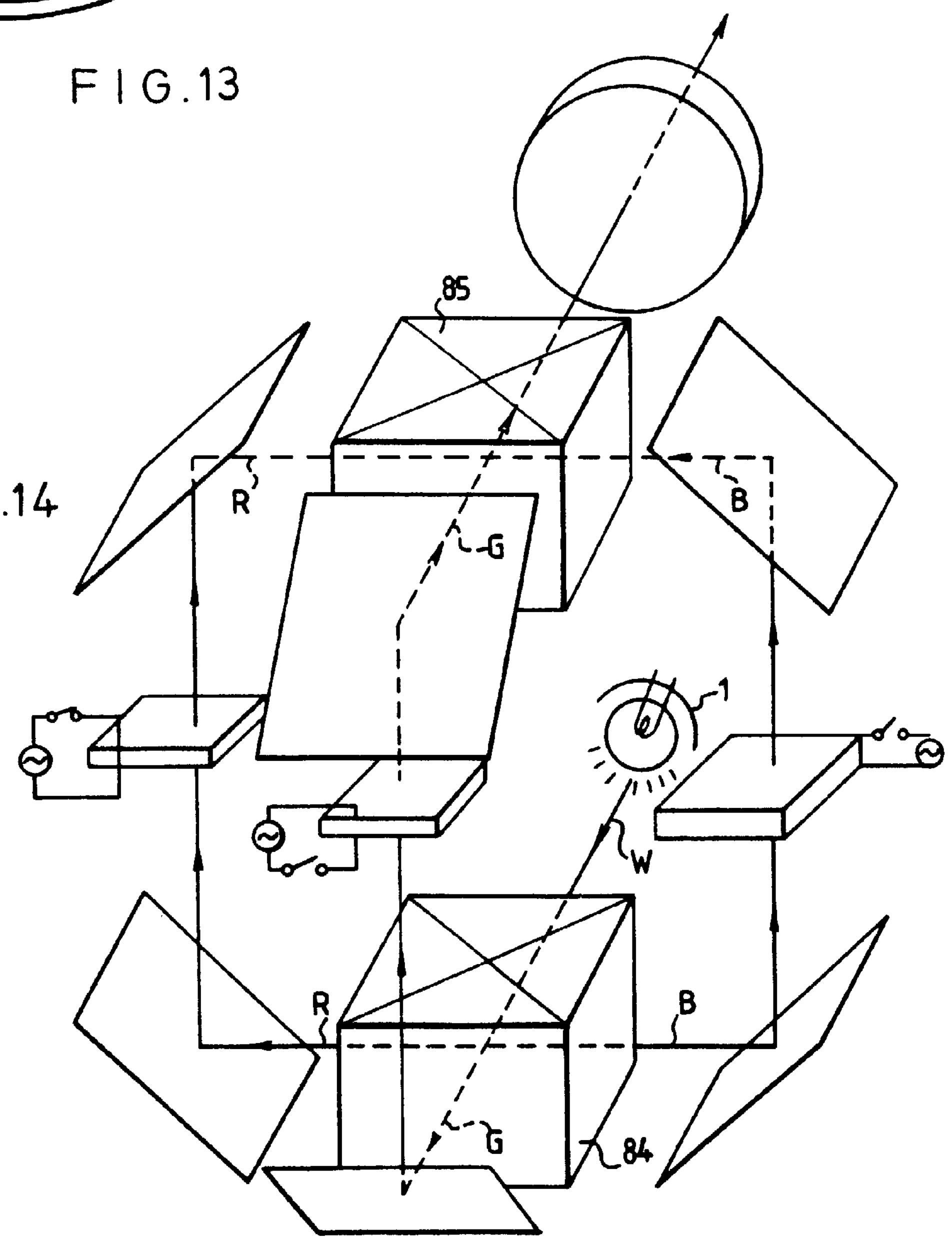

83d
To Red Filter
83a
1
To Green Filter
83c
83e
83b
83f
To Blue Filter

FIG.13

FIG.14


85
R
B
G
1
W
R
B
G
84